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DETERMINANTS OF PHYSICAL ACTIVITY AMONG 6-8 YEARS OLD SCHOOL CHILDREN IN KUOPIO, FINLAND: PHYSICAL ACTIVITY AND NUTRITION IN CHILDREN (PANIC) STUDY

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Master's Thesis

Public Health

School of Medicine

Faculty of Health Sciences

University of Eastern Finland

November 2014

UNIVERSITY OF EASTERN FINLAND, Faculty of Health Sciences
Public Health
Ali, Sheraz: Determinants of physical activity among 6-8 years old school children in Kuopio, Finland: Physical Activity and Nutrition in Children (PANIC) Study
Master's thesis, 52 pages
Instructors: Jorma Räsänen, DrPH., Arja Erkkilä, Docent, PhD and Juuso Väistö, M.Sc
November 2014

Keywords: children, physical activity, determinants, Kuopio

DETERMINANTS OF PHYSICAL ACTIVITY AMONG 6-8 YEARS OLD SCHOOL CHILDREN IN KUOPIO, FINLAND: PHYSICAL ACTIVITY AND NUTRITION IN CHILDREN (PANIC) STUDY

Physical activity has numerous beneficial effects on the health of human being and is known to decrease the risk of cardiovascular diseases, diabetes mellitus, obesity, osteoporosis, certain cancers and mental health, as well. Physical activity is a multi-dimensional behavior that is affected by several determinants i.e. demographic, biological, environmental, behavioral, socioeconomic and socio-cultural factors. Emerging evidence indicates that persistent childhood physical activity also helps an individual to remain active in adolescence and adulthood, which is one of the vital objectives of public health. Previous studies mostly deal with the behavior correlates and there is a paucity of data on determinants of physical activity among children. The aim of this study was to assess the determinants of total physical activity during early stage of life.

This study was conducted as part of Physical Activity and Nutrition in Children (PANIC) Study which is an ongoing and long-term controlled physical activity and diet intervention study in a population sample of healthy children of 6 to 8 years of age in Kuopio, Finland. Total of 512 children participated in baseline examinations while data on determinants and physical activity required for this cross-sectional study was available for 350 children (183 boys and 167 girls) at baseline.

Boys' physical activity was comparatively higher (840 min/week vs. 751 min/week) than girls' and engagement in sedentary behavior was higher among girls (1598 min/week vs. 1414 min/week) as compared to boys. Boys showed better cardiorespiratory and neuromuscular performance in most of the fitness tests than girls. Cardiorespiratory fitness, total body lean mass and parents' education had positive association with total physical activity of children while total body fat percentage, electronic media time and low household income had negative association with children's total physical activity. Total body lean mass was the strongest determinant of physical activity among boys, while it was not a significant determinant in girls. Low household income had negative association with total physical activity in girls, but not in boys.

This study concluded that cardiorespiratory fitness, total body lean mass, total body fat percentage, electronic media time, low household income and parents' education were the key determinants of total physical activity among 6-8-years-old boys and girls of Kuopio, Finland.

FOREWORD

I am indebted to Professor Timo Lakka for providing an opportunity to become a part of PANIC study. I thank to my supervisors, Jorma Räsänen, Arja Erkkilä and Juuso Väistö for providing guidance and invaluable help to complete the thesis. I will always remember their kindness and try my level best to utilize research skills in future as well that I acquired especially from Arja and Juuso.

I would like to express my gratitude to the entire faculty of Institute of Public Health and Clinical Nutrition, especially Dr. Sohaib Khan for providing an in-depth knowledge about public health and research process which also helped me during thesis. I thank Mr. Tommi Eskelinen from Learning Centre for providing guidance on IT related matters and always liked his humble attitude throughout my study period in University of Eastern Finland.

I take this opportunity to express heartfelt gratitude for my venerable mentors Dr. Khawar Mehdi and Jaffer Bin Baqar for providing strong research base and guidance about the scientific writing during the initial days of my career. I also extend thanks to my friend Dr. Hamza Shaikh for his unwavering support and motivation.

I dedicate this thesis to my parents and siblings for being real asset of my life.

Thank you

Sheraz Ali

CONTENTS

ABBREVIATIONS

ALT	Alanine aminotranferase
GGT	Gamma-glutamyl tranferase
HBM	Health Belief Model
HDL	High-density lipoprotein
IFCC	International Federation of Clinical Chemistry
LDL	Low-density lipoprotein
MVPA	Moderate-to-vigorous physical activity
SES	Socioeconomic status
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

1. INTRODUCTION

Physical activity is defined as "any bodily movement produced by skeletal muscles that requires energy expenditure" (WHO, 2014). On the contrary, sedentary behavior is defined as group of activities that occurs during sleeping, sitting and lying down, and requires low level of energy expenditure i.e. $\leq$ 1.5 metabolic equivalents (Pate et al. 2008). Most of the chronic diseases usually occur in middle aged and older adults but its development phase begins in early childhood and adolescence (Hallal et al. 2006). Regular physical activity in children has beneficial effects on cardiovascular and metabolic diseases, but physical activity levels gradually decline during childhood and adolescence (Brage et al., 2004; Nader et al., 2008).

One of the vital objectives of public health is to maintain the utmost level of physical activity during the course of life (Corder et al. 2009). Strategies for the promotion of physical activity have somehow succeeded globally in order to reduce the decline in physical activity, which is associated with the age (van Sluijs et al. 2007). The decline in physical activity also associated with gender and greater decline has been measured among girls as compared to boys (van Sluijs et al. 2007).

Many children and adolescents follow sedentary lifestyle approach by playing video games and watching television at home while their outdoor physical activities are quite limited and therefore sedentary behavior is associated with poor health outcomes (WHO 2003). A systematic review of 46 studies published in 2011 in order to assess the determinants of change in physical activity in children and adolescent, concluded that further research is still needed for the determinant of change in physical activity because of the exposure and heterogeneity of study samples studied earlier. Moreover, determinants were only measured among different age groups and investigations of individual factors were overlooked in previous studies. Factors affecting physical activity include demographic, socio-cultural, psychological and environmental factors (Craggs et al. 2011).

Sallis and Owen (1999) categorized the predicting factors of physical activity into five groups: demographic and biological factors, psychological, cognitive, and emotional factors, behavioral attributes and skills, socio-cultural factors, and environmental factors. Social and physical environment can affect the physical activity in adolescents. Sedentary behaviors including the use of computer or playing video games and demographic factors including age and gender are potential determinants of physical activity (Zimmermann-

Sloutskis et al. 2010). Behavioral factors are also responsible for decreased physical activity in adolescents (Higgins et al. 2003).

Physical activity habits during childhood may persist during the adolescence and adulthood phases of life which reflects the importance of physical activity in early age. In order to design an effective intervention strategy to increase the physical activity during adulthood, we need to find all possible determinants that play a key role during early stage of life. Most of the existing literature deals with behavior correlates instead of investigating the determinants of physical activity behavior.

2. LITERATURE REVIEW

2.1 Importance of physical activity and sedentary behavior in children

Physical activity is a multi-dimensional behavior that is determined by various factors such as physiological, demographic, environmental, social and cognitive determinants (Kohl & Hobbs, 1998; Sallis & Owen, 1999). There is strong evidence that physical activity has many beneficial effects on human health and decreases the risk of cardiovascular diseases, diabetes mellitus and some malignant tumors while sedentary behavior is considered as largest public health issue of the 21st century (Blair, 2009). According to World Health Organization (WHO), sedentary behavior annually attributes to approximately 2 million deaths across the globe (WHO, 2004). Moreover, sedentary behavior is also responsible for high disability and death rates in industrialized countries (WHO, 2002).

Dietary habits which are injurious to health and some environmental determinants are considered as promoting factors for obesity and overweight problems in children which ultimately lead to decline in physical activity (Sigmund et al., 2007). Physical activity during childhood helps to prevent the obesity and overweight issues during adolescence and several factors during childhood can influence the physical activity behavior among children (Moore et al. 2003).

A 21-Year Tracking Study of Finland concluded that persistent physical activity during childhood significantly increases the chances to remain active during the maturity phase of life (Telama et al. 2005). According to Finnish Recommendations for Physical Activity in Early Childhood Education in Finland, all children under the age of seven should perform at least 2 hours of daily physical activity (Ministry of Social Affairs and Health, 2005).

According to the Finnish 2014 Report Card on Physical Activity for Children and Youth, physical activity levels in Finnish children are quite low compared to recommended levels and it is due to the involvement in sedentary pursuits, which emphasize the need to reduce unhealthy behavior and promote physical activity among Finnish children and youth by conducting a research to find psychosocial, environmental and biological determinants. The recommended level of at least 60 minutes of moderate-to- vigorous physical activity (MVPA) reported by 30% and 18% in Finnish boys and girls, respectively reflects the evident gender difference in Finnish population. Moreover, this report also shows that 24% of eleven to fifteen years old Finnish children followed daily recommended guidelines of

at least 60 minutes of MVPA as compared to the international data available on physical activity (Grasten et al. 2014).

2.2. Behavioral change theories and models

There are number of theories and models for behavioral change and health promotion while the most frequently used models are Social-Cognitive Theory and Health Belief Model (HBM), which are also applicable and relevant to our research topic as well.

2.2.1. Social-cognitive theory

Social cognitive theory was postulated by Canadian psychologist Albert Bandura, in 1986. It was based on ideas that individual acquires or learns by observing other individuals in the surrounding environment (Bandura, 1977). Moreover, social psychologists agree that environment plays an important role to influence the behavior of an individual by many ways. Albert Bandura was the first one who postulated that changes in an individual behavior were primarily mediated by self-efficacy which helps the individual to effectively execute the desired behavior in order to prevent the disease (Strauss et al. 2001).

Social-cognitive theory has also been used in several earlier studies to understand the behavioral patterns in children which include the child beliefs and the influence of parents, peers and school on children's physical activity (Strauss et al., 2001; Taylor et al., 1994).

2.2.2. HBM

The HBM is a psychological model to predict the health-related behavior, developed in the 1950s by social psychologists Hochbaum, Rosenstock and Kegels at the U.S. Public Health Services in order to understand the reasons behind the failure of tuberculosis screening programs. HBM is also considered as widely used theory in health behavior research (Glanz et al. 2008).

Many other researchers have also expanded the Hochbaum's model of health behavior which was based on screening behavior, to include sick-role behavior, illness behaviors and preventive actions (Becker, 1974; Janz & Becker, 1984; Kirscht, 1974; Rosenstock, 1974). Key constructs of HBM include perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy.

Perceived susceptibility refers to individual's perception about the occurrence of any disease or condition which may vary among individuals impact (Janz et al. 2002).

Perceived severity refers to individual's assessment about the consequences and severity of disease and its effect on their health (e.g. death, pain and discomfort) and social matters such as financial problems and difficulty in maintaining the relationship with family members (Janz et al. 2002).

Perceived benefits refer to individual's belief for taking action in order to prevent disease which also shows the patient awareness about the seriousness of disease as well (Janz et al. 2002).

Perceived barriers refer to individual's belief about the tangible and psychological costs of the advised action. These barriers may prevent an individual to take the desired action in order to prevent the disease and promote health (Janz et al. 2002). For example, children may feel fear from strangers while playing outdoors, worst weather situation and excessive home work.

Cues to action refer to the strategies to activate one's "readiness" (Janz et al. 2002). Cues to action can be external such as providing how-to information, media and use of suitable reminder system while the internal cues can be physiological such as pain and symptoms of illness (Carpenter, 2010).

Self-efficacy is defined as "the conviction that one can successfully execute the behavior required to produce the outcomes" (Bandura, 1977). A conviction can influence the decisions by maintaining a behavior which leads to the promotion of physical activity.

2.2.3. HBM in regard to physical activity of children

A cross-sectional study which was conducted in children found that perceived benefits, perceived barriers and cues to action had enormous influence on children physical activity and also reported that perceived support from parents and peers increased the self-efficacy levels in these children (Ar-Yuwat et al. 2013). Many earlier studies also found self-efficacy as the most important construct of HBM which was studied frequently and reported its positive association with physical activity behavior in children and adolescents (van Der Horst et al, 2007; Motl et al, 2002; O'Loughlin et al., 1999; Trost et al, 1997).

Several studies found that perceived barriers decrease the promotion of physical activity in children and likelihood of engaging in preventive health practice (Sallis et al., 2000; Ar-Yuwat et al, 2013).

2.3. Determinants for physical activity

2.3.1. Environmental determinants

According to Gordon-Larsen et al (2000), prime determinants for physical activity and inactivity are not similar, because environmental factors affect the physical activity while socio-demographic factors have strong association with sedentary behavior.

Environmental factors including the facilities of school and community programs, facility of fitness equipment at home, physical environments, physical safety, and exercise opportunities have all been found to be significant determinants of physical activity in adolescents (Felton et al., 2002; Gordon-Larsen, McMurray & Popkin, 2000; Lindquist, Reynolds & Goran, 1999; Nelson, Gordon-Larsen, Song & Popkin, 2006; Strauss et al., 2001; Ward et al., 2006). Participation in school physical education was significantly associated with possibility of engaging in MVPA for a nationally representative sample of over 17,000 adolescents' ages 11 to 21 years in United States (Gordon-Larsen et al. 2000). Community recreation centers also help the adolescents in order to engage them in MVPA except in those who do not use these centers (Gordon-Larsen et al. 2000). The participation of organized sports at school and community increased the levels of physical activity among White and African American high school female adolescents (Ward et al. 2006).

Moreover, crime rates also act as a potential determinant of physical activity and promote the inactivity especially for African American adolescents who are residents of high crime localities but its impact is not as strong as school physical education and the use of community recreation centers (Gordon-Larsen et al. 2000). High crime levels lead to decline in the physical activity among adolescents (Pate et al. 1996). According to Molnar et al. 2004, children were physical active for an additional forty nine minutes a week in safe vicinities as compared to the vicinity where crime rates were high.

External factors also affect physical activity in adolescents such as the decline in physical activity during winter and especially during snowfall in Canada (Belanger et al. 2009). Gordon-Larsen et al. (2000) also studied the effect of season on physical activity in

adolescents and found that there was no association between month and patterns of physical activity.

2.3.2. Socio-cultural determinants

Several reviews that were conducted earlier concluded that social factor such as the influence of parents exerted a strong impact on children's activity (Sallis et al. 2000). Parents have a strong influence on children and adolescent physical activity by providing moral support (Sallis et al. 2000).

There is an association between physical activity and socio-cultural determinants when parents especially fathers act as role models by their behavior and encourage their daughters to be active (Davison et al., 2003; Moore et al., 1991). Moreover, support from family and friends also promote physical activity in children (Davison, 2004; Prochaska et al., 2002; Sallis et al., 1999a; Sallis et al., 2000).

Another study which was conducted in 9-year old children found that parents who participated regularly in playing activities with their children significantly increased their children's physical activity levels (Strauss et al., 2001). Several studies have found significant association between parental support and physical activity among adolescents (Anderssen & Wold, 1992; Davison & Schmalz, 2006; Gustafson & Rhodes, 2006; Schmitz et al., 2002; Trost et al., 2003; Ward et al., 2006).

Using data from National Longitudinal Study of Adolescent Health, Ornelas et al. (2007) found that parent engagement, family cohesion and mother-child communication were prime characteristics that result in higher levels of physical activity among 13,000 adolescents in the United States. Moreover, Ornelas et al. (2007) found that mother-child communication is comparatively stronger in female adolescents than male adolescents while male adolescents have higher levels of family cohesion than female adolescents.

Some studies also examined the association between adolescent physical activity and maternal parenting style that can vary among boys and girls. According to Schmitz et al. (2002), young girls whose mothers fulfilled demands and needs by following the authoritative parenting style showed higher levels of physical activity. On the contrary, non-authoritative style of parenting was associated with high level of physical activity in seventh grade male students. Due to socio-cultural factors, girl's participation in physical activity was quite low as compared to boys and this was due to lack of support from

teachers in schools and parents as well which tend to create a gender gap in activity (Thomas, 1988).

2.3.3. Psychological, cognitive and emotional determinants

Self-efficacy is an important psychological factor which is considered as predictor of individual behavior. Previous studies have documented several psychological factors such as self-efficacy, perceived benefits of physical activity, attitude towards physical activity, motivation, enjoyment, and health beliefs to be considerably associated with physical activity (Dishman et al., 2005; Dishman et al., 2006; Felton et al., 2002; Garcia et al., 2006; Kohl & Hobbs, 1998; Lemmon et al., 2007; Motl et al., 2002; Sallis et al., 1999a; Strauss et al., 2001; Ward et al., 2006).

Dishman et al. (2006) conducted a study on more than 400 black and white girls of 9th and 12th grade and found that high self-efficacy levels in girls increased their physical activity. Another study which was conducted on 5th grade children in a rural area found that self-efficacy is an important predictor of physical activity (Trost et al., 1997).

Another study found the considerable positive association between self-efficacy and physical activity by concluding that more active children of 6th grade reported higher self-efficacy than low active 6th grade children (Trost et al., 1999b). A study conducted on more than 300 children of 5th grade concluded that those children who were involved in vigorous activity reported higher self-efficacy as compared to low active children (Pate et al., 1997).

According to Trost et al. (2001), obese children in the 6th grade reported low physical activity due to low levels of self-efficacy and authors of this study suggested to increase the self-efficacy among obese children in order to promote their physical activity. Several earlier studies also reported the positive association between self-efficacy and physical activity among children and adolescents (Reynolds et al. 1990; Trost et al. 1996; Zakarian et al. 1994).

Health beliefs such as perceived benefits and perceived barriers, and attitudes are the most important determinants of physical activity in children. Moreover, children usually take part in those activities for which they have a positive attitude (Kohl & Hobbs, 1998). According to Deforche et al. (2004), perceived benefits promote the physical activity while perceived barriers tend to decrease the physical activity levels. Moreover, enjoyment is an

important determinant that had positive association with physical activity among children and adolescents (Stucky-Ropp and DiLorenzo 1993; Tinsley et al. 1995). According to Sallis et al. (1999a), factors such as perceived competence and activity preference were reported to have a significant association with physical activity among 4th and 5th grade children.

2.3.4. Behavioral attributes and skill factors

A cross sectional study of over 400 Canadian children found that reduction in sedentary behavior (i.e., watching television and playing video games on computer) will promote the physical activity at all phases of life. Moreover, the measurement of sedentary behavior at early life will also help the researchers to determine the effects of intervention methods i.e. direct observation, parent-report, pedometers and accelerometers (Colley et al. 2013).

Systemic review of more than 200 studies found that school-aged children who spend more than two hours daily in sedentary activities reported lower fitness level, and concluded that inactivity issues in children can be resolved by minimizing the sedentary attitude and promoting the awareness of physical activity among children (Tremblay et al. 2011). According to Epstein et al. (2000), sedentary behavior is inversely associated with physical activity among 8 to 12 years-old children.

Physical activities that were performed at early stages of life act as important predictor of current physical activity in adolescents (De Bruijin et al. 2006). A cross sectional study of more than 300 African-American 4th and 5th graders found that students who were following healthy behaviors such as intake of nutritious food and exercise were one-third less likely to smoke a cigarette or consume alcohol than those students who took part in only few healthy activities (D'Elio et al. 1993). Another study conducted on rural school children found positive association between healthy diet and physical activity (Terre et al. 1990). Study conducted on Canadian youth found that smoking and alcohol consumption lead to decline in physical activity among adolescents (Higgins et al. 2003).

2.3.5. Demographic and biological determinants

The knowledge of physical activity determinants would be considerably enhanced by inspection of correlates such as gender and age, which were earlier identified in various cohort studies (Craggs et al. 2011). A review of 108 studies published in 1999 concluded that demographic variables such as gender, age and biological variable such as body weight were studied more frequently in earlier studies (Sallis et al. 2000). Age related

difference in physical activity has been observed among boys and girls that should be explored further in future research (Dumith et al. 2011).

Gender, age and socioeconomic status (SES) were the most studied demographic factors in earlier studies of children and adolescent while gender was the most consistent demographic factor that was significantly associated with the change in physical activity (Craggs et al. 2011). During the age of nine to fifteen years, gender and age were the prime determinants of moderate-to-vigorous physical activity (MVPA) while SES was also associated with significant decline in MVPA (Nader et al. 2008). Another study which was conducted on children found that girls with high SES reported a greater decline in sedentary behavior such as watching television (Ball et al. 2009).

According to Schmitz et al. (2002), girls are comparatively more active than boys when both parents have completed college education. Highly educated mothers of adolescents play a major role to involve them in MVPA. There is also a significant association between the family income and physical activity as higher family income increased the likelihood of adolescent's participation in MVPA (Gordon-Larsen et al. 2000).

Prior studies have also examined that transportation which is provided by parents to their children in order to participate in activities at sports club and paying membership fees of these organizations eventually resulted in high levels of physical activity among children (Sallis et al., 1992; Sallis et al., 1999a). Study conducted on 6.5 to 13 years age of children in the United States found that children who are residents of single-parent home reported lower levels of physical activity as compared to children living in two parent homes (Lindquist et al., 1999).

According to Cairney et al. (2014), biological processes that are involved in growth and development also play an important role in the decline of physical activity among adolescents as girls reported significant decline in participation in physical activity as compared to boys in this study. According to Sallis et al. (1999a), girls of 4^{th} and 5^{th} grades reported larger decline in physical activity than boys.

Several population based studies have concluded that children and adolescents of ethnic minorities have lower physical activity levels than Caucasians (Taylor et al. 1998). Mexican American preschoolers showed less activity as compared to white children during both indoor and outdoor activities (McKenzie et al. 1992). Physical activity was low in

non-Hispanic black and Hispanic adolescents (Gordon-Larsen et al. 2000). SES factor is also considered as potential confounder for ethnic differences in health behaviors and outcomes (Sallis et al. 2000). According to Sallis (2000), girls and those belong to ethnic minorities are considered as high risk inactive individuals and they need special intervention programs at early stages of life.

2.4. Summary of physical activity determinants

Figure 1 summarizes the determinants of physical activity based on literature.

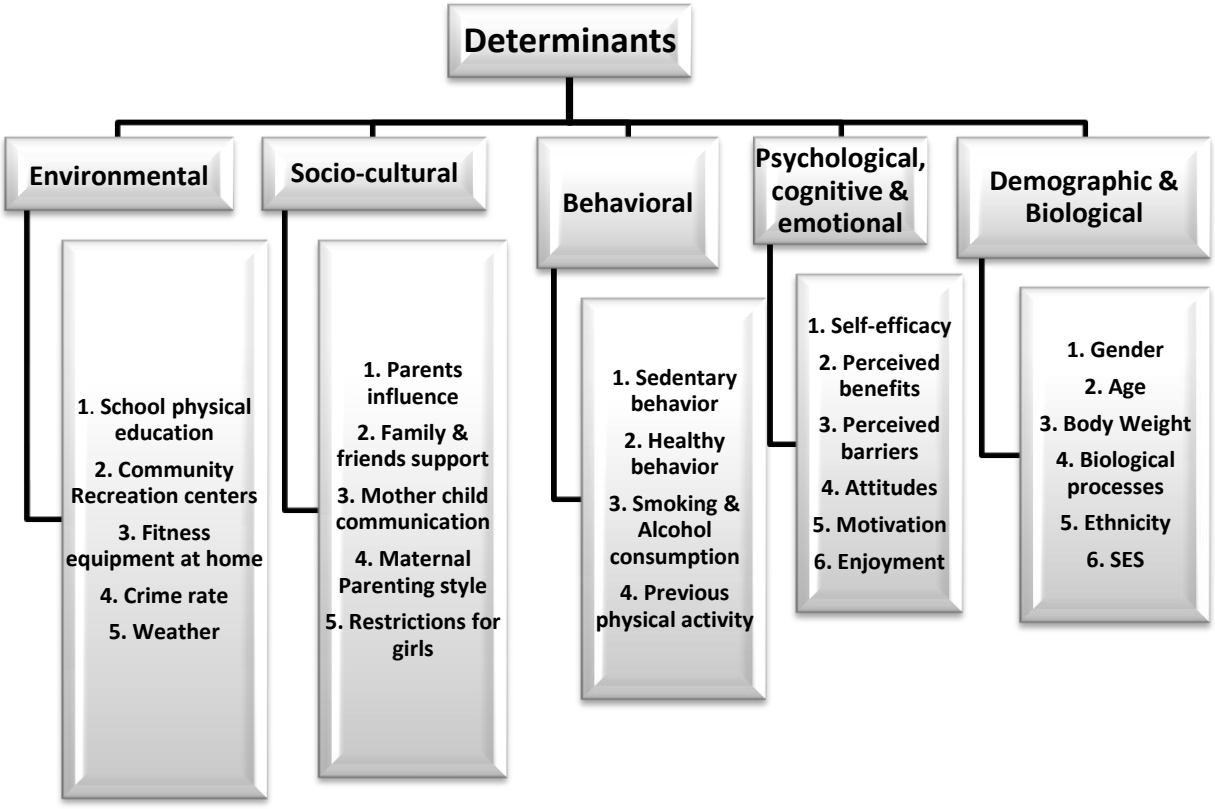

Figure 1. Summary of physical activity determinants based on literature

3. OBJECTIVE

The primary objective of the study was to explore and recognize the determinants of total physical activity among 6-8-years-old primary school children in Kuopio, Finland.

Specific aims of the study were

1) to describe the physical activity and sedentary behavior characteristics among boys and girls.
2) to analyze the determinants of physical activity in the whole study population and separately for boys and girls.

4. METHODS

4.1. Study design and study population

PANIC Study is an ongoing and long-term controlled physical activity and diet intervention study in a population sample of healthy children of 6-8 years of age from Kuopio, Finland. After research ethics committee approval, verbal and written informed consents were taken from parents and children. Overall 732 children were officially invited during 2007-2009 for baseline examinations while 512 children participated in the baseline examinations. 309 children were allocated into the intervention group and 203 children were allocated into the control group. Complete data on variables used in this analysis were available for 350 children (183 boys and 167 girls) at baseline.

4.2. Demographics and biomarkers

PANIC study questionnaire was administered to assess age and sex of children. Wall-mounted stadiometer and Inbody 720® bioimpedance device was used to measure body height and weight, respectively. Body weight was divided by body height squared for BMI while national references were used to find the BMI- standard deviation score (Saari et al. 2011). Waist circumference was measured between the bottom of the rib cage and the apex of the iliac crest. Lunar® dual energy x-ray absorptiometry (DXA) device was used to measure body lean mass and body fat percentage (BF%) while cut-off values of categorized BF% were $\leq$ 20 % body fat, 20.1-33% body fat and > 33% body fat.

Blood pressure i.e. systolic and diastolic blood pressures were recorded by a calibrated aneroid sphygmomanometer (Heine 130 Gamma G7, Munich, Germany). Three measurements were taken in the sitting position at two minutes interval after the rest of 5 minutes and their mean reading was used as systolic and diastolic blood pressure.

Qualified nurse took venous blood samples-after twelve hours of overnight fast at Institute of Biomedicine, University of Eastern Finland. Serum insulin, plasma glucose, high density lipoprotein (HDL), low density lipoprotein (LDL), triglycerides, plasma urate, plasma alanine aminotranferase (ALT) and plasma gamma-glutamyl transferase (GGT) were assessed and methods have been described earlier (Viitasalo et al. 2012). Plasma glucose was measured by hexokinase method (Roche Diagnostics Co, Mannheim, Germany). Electrochemiluminescence immunoassay was done to analyze serum insulin and colorimetric enzymatic assay was performed to analyze plasma triglycerides and plasma total cholesterol (Roche Diagnostics Co). HDL and LDL cholesterols were

analyzed by homogeneous enzymatic colorimetric assay (Roche Diagnostics Co). Plasma urate, ALT and plasma GGT (Roche Diagnostics Co) were analyzed by kinetic method according to IFCC.

4.3. SES information

PANIC study questionnaire was administered to collect the SES data including annual household income and parental education. Annual household incomes were classified into 3 categories i.e. $\leq$ 30000 €, 30001-60000 € and $\geq$ 60001 €. Parental education was also classified into 3 categories i.e. vocational school or less, college or other high vocational degree and university.

4.4. Meals and snacks intake

Main meals were categorized into breakfast, lunch and dinner while eating and drinking between the meal times were classified as snacks. The average number of meals and snacks that were eaten per day were assessed by food records of four consecutive days.

4.5. Sleep duration

The questions related to sleep were asked from parents by using the PANIC study questionnaire. They were asked about current sleep behaviors of their child and average time of sleeping (hours) was asked in 30 minutes' accuracy. We categorized sleep into <10 and $\leq$ 10 hours groups.

4.6. Fitness

Exercise stress test was performed under the supervision of physician and a nurse by electromagnetic cycle ergometer (Ergoselect 200K, Ergoline, Germany) in order to determine the maximal achieved work load i.e. cardiovascular fitness. Warm-up period of 3 minutes were tested at a workload of 5 watts while steady state period of 1 minute at a workload of 20 watts. Moreover, after every 6^{th} second work load was increased by one watt until exhaustion condition and cool-down period consisted of 4 minutes at a workload of 5 watts.

Neuromuscular fitness of children was assessed with a modified flamingo balance test where the child was instructed to stand on one leg without opening of eyes. The test score was the number of errors i.e. floor touches with a barefoot or opening of the eyes during 30 seconds. Sit and reach test was performed by wearing heels and the distance between the heels were twenty five centimeters and then measuring stick was placed at a distance of

thirty eight centimeters from the zero line that was pre-set, then children were instructed to move slowly in forward motion with parallel hands and finally out of 3 attempts (based on longest distance covered by fingertips that started from 38 centimeters) the best result was recorded.

Handgrip strength of right and left hand was determined by Martin vigorimeter (Tuttlingen, Germany) by instructing the children to keep their elbow near to body and flexing their arm to 90 degree and the best result was recorded after three attempts of maximal effort presses by both hands.

4.7. Physical activity

PANIC Physical Activity Questionnaire was administered by parents at home to evaluate the physical activity during a standard week. Physical activity during recess, structured exercise, organized sports, unstructured physical activity and commuting to and from school, were the types of physical activity assessed. The frequency and single duration of each aforementioned physical activity type were expressed in weekly and hourly sessions, respectively. Weekly physical education at school of ninety minutes of all 1^{st} grade children was included in the total physical activity.

4.8. Media time and sedentary activities

Media time included watching television or videos, using computer or playing video games, using mobile phone and playing mobile games while sedentary activities included listening to music, playing a musical instrument, reading, writing, drawing, doing arts and crafts, playing board games and resting on weekdays. Total weekly media time and total weekly sedentary activity time were calculated by totaling the amount of each media time and sedentary activity performed on weekdays and weekend.

4.9. Study variables

Table 1. Variables tested as determinants of total physical activity.

Variables
DEMOGRAPHIC AND BIOLOGICAL
• Age, years • Sex • Total body fat percentage, % • Total body lean mass, kg
SES
• Annual Household Incomes, Euros (≤ 30000 €, 30001- 60000 €, ≥ 60001 €) • Parent education (Vocational school or less, college or other high vocational degree, university)
BEHAVIORAL
• Hours slept at night, h • Total electronic media time (min/week, for model 1)* • Total sedentary activities (min/week, for model 2)* • Number of main meals per day • Number of snacks per day
FITNESS TEST
• Maximal workload per total body lean mass, W/kg • Maximal workload per weight, W/kg • A modified flamingo balance, times/30s. • Sit and reach, cm • Handgrip strength, right hand, kPa • Handgrip strength, left hand, kPa

*Models are explained in the statistical methods.

4.10. Ethical issues and risk management

The approval of the PANIC Study protocol and the permission to conduct the study was received from the Research Ethics Committee of Hospital District of Northern Savo in 2006. The children and their parents' consent were taken before the initiation of the study and informed verbally and in writing about the details of the study. The study has taken insurance for the children in case of bouts of illness and accidents during examinations or interventions.

4.11. Statistical methods

Statistical analyses were performed with the SPSS software, Version 21.0 (IBM Corp, Armonk, NY). Differences in means of basic characteristics, fitness test results, physical activity and sedentary behavior characteristics between genders were tested with the independent samples t-test while common activities among boys and girls were analyzed by frequency distribution. The association of determinants with total physical activity was analyzed by linear regression stepwise models in the whole study population and also separately for boys and girls using a P value of <0.05 as the entry criterion. The variables entered in the models are shown in table 1 and two models were created so that electronic media time was entered in model 1 and sedentary activities in model 2.

5. RESULTS

5.1. Basic characteristics

Complete data consisted of 350 children (183 boys, 167 girls). Table 2 describes the demographic, biological, biomarkers, SES and behavioral characteristics of primary school children of Kuopio. The mean (standard deviation) age of children was 7.7 (0.4) for both genders. Boys were taller (129.6 cm vs. 128.2 cm), weighed almost equal (27.2 kg vs. 26.6 kg), and had a lower total body fat percentage (17.10 % vs. 22.18 %) and higher total body lean mass (21.57 kg vs. 19.75 kg) than girls. Boys' family household incomes belonged more often in the highest third (≥60000€/year) than girls' family household incomes. Girl's parents had more often college or other high vocational degree than boy's parents.

Table 2. Demographic, biological, biomarkers, SES, and behavior characteristics in boys and girls.

	All (N=350)	Girls (N=167)	Boys (N=183)	P-value [b]
DEMOGRAPHIC AND BIOLOGICAL				
Age, years	7.7 ± 0.4 [a]	7.6 ± 0.3	7.6 ± 0.4	0.232
Weight, kg	27.0 ± 5.0	26.6 ± 5.0	27.2 ± 5.0	0.359
Weight Standard Deviation Score	0.4 ± 1.0	0.29 ± 1.0	0.4 ± 1.1	0.201
Total body fat percentage, %	19.54 ± 8.11	22.18 ± 7.41	17.10 ± 7.97	<0.001
Total body lean mass, kg	20.70 ± 2.27	19.75 ± 1.99	21.57 ± 2.17	<0.001
Height, cm	129.0 ± 5.3	128.2 ± 5.3	129.6 ± 5.3	0.013
Height Standard Deviation Score	0.6 ± 1.0	0.6 ± 0.9	0.7 ± 0.9	0.279
Body Mass Index, kg/m^2	16.1 ± 2.1	16.1 ± 2.1	16.0 ± 2.1	0.756
Body Mass Index Standard Deviation Score	0.02 ± 1.0	-0.001 ± 1.0	0.04 ± 1.1	0.692

Waist Circumference, cm	57.0 ± 6.0	56.1 ± 5.4	57.2 ± 6.0	0.063
BIOMARKERS IN FASTING				
Blood Hemoglobin, g/l	125.0 ± 8.0	125.1 ± 8.0	124.8 ± 7.3	0.670
Plasma Glucose, mmol/l	4.82 ± 0.39	4.77 ± 0.37	4.88 ± 0.41	0.007
Plasma Total Cholesterol, mmol/l	4.29 ± 0.61	4.32 ± 0.61	4.25 ± 0.61	0.260
Plasma HDL Cholesterol, mmol/l	1.61 ± 0.31	1.56 ± 0.31	1.64 ± 0.31	0.023
Plasma LDL Cholesterol, mmol/l	2.40 ± 0.51	2.42 ± 0.52	2.31 ± 0.49	0.043
Plasma Triglycerides, mmol/l	0.60 ± 0.30	0.62 ± 0.26	0.59 ± 0.25	0.251
Plasma ALT, U/I	19.0 ± 6.1	18.3 ± 5.3	18.8 ± 6.1	0.435
Plasma Urate, umol/l	199.5 ± 39.5	200.3 ± 39.0	198.6 ± 39.9	0.684
Plasma GGT, U/l	11.6 ± 2.6	11.6 ± 2.6	11.8 ± 2.7	0.448
SES				
Annual Household Incomes, Euros				
≤ 30000 €	61 (17.4) [c]	32 (19.2)	29 (15.8)	0.414 [d]
30001- 60000 €	152 (43.4)	79 (47.3)	73 (39.9)	0.162
≥ 60001 €	137 (39.1)	56 (33.5)	81 (44.3)	0.040

Parental Education				
Vocational school or less	64 (18.3)	30 (18.0)	34 (18.6)	0.882
College or other high vocational degree	163 (46.6)	87 (52.1)	76 (41.5)	0.048
University	123 (35.1)	50 (29.9)	73 (39.9)	0.051
BEHAVIORAL				
Hours slept at night, h.	9.8 ± 0.5	9.82 ± 0.5	9.9 ± 0.5	0.170
Number of main meals per day	2.7 ± 0.25	2.7 ± 0.24	2.76 ± 0.26	0.310
Number of snacks per day	2.7 ± 0.9	2.66 ± 0.9	2.66 ± 0.8	0.980

[a] Mean ± SD, [b] Independent samples t-test, [c] n (%), [d] Chi-squared test

Fitness test results of boys and girls are shown in table 3. Results show generally better cardiorespiratory and neuromuscular performance in boys than girls except for modified flamingo balance test.

Table 3. Fitness tests.

	All (N=350)	Girls (N=167)	Boys (N=183)	P-value [b]
Maximal achieved work load in exercise stress test, W/kg	76.9 ± 15.2 [a]	70.55 ± 12.5	82.7 ± 15.05	<0.001
Maximal workload per total body lean mass, W/kg	3.71 ± 0.51	3.58 ± 0.50	3.84 ± 0.48	<0.001
Maximal workload per weight, W/kg	2.90 ± 0.53	2.68 ± 0.45	3.10 ± 0.52	<0.001
A modified flamingo balance test, times/30s	3.9 ± 3.0	3.2 ± 2.3	4.49 ± 3.1	<0.001
Sit and reach, cm	-3.5 ± 8.0	-0.15 ± 7.25	-6.4 ± 7.3	<0.001
Handgrip strength, right hand, kPa	47.8 ± 9.0	45.37 ± 9.0	50.0 ± 8.4	<0.001
Handgrip strength, left hand, kPa	46.9 ± 9.0	45.26 ± 8.2	48.4 ± 9.0	0.001

[a] Mean ± SD, [b] Independent samples t-test

Table 4 describes the physical activity and sedentary behavior characteristics among girls and boys. An independent samples t-test was conducted to compare total physical activity (min/week) between boys and girls and there was a significant difference in the scores for boys and girls (p=0.005). Specifically, our results suggest that boy's total physical activity levels are comparatively higher than girls. There were more boys (381 vs. 318) than girls who spent time in unstructured physical activity.

According to Table 4, boy's participation in structured and unstructured exercise was significantly higher than girls. There was also a significant difference in sedentary activities among boys and girls (p=0.020) and results suggest that engagement in sedentary activities was considerably higher in girls than boys. Boys' participation in electronic media time activities was significantly higher than girls' (p=<0.001).

Table 4. Physical activity and sedentary behavior in boys and girls.

	All (N=350)	Girls (N=167)	Boys (N=183)	P-value [b]
Total physical activity, min/week	797 ± 295 [a]	751 ± 277	840 ± 305	0.005
Unstructured physical activity, min/week	351± 221	318 ± 219	381 ± 219	0.008
Structured exercise, min/week	45± 82	34 ± 47	56 ± 104	0.008
Structured exercise, times/week	2 ± 1	2 ± 1	2 ± 1	0.023
Unstructured exercise, times/week	5± 1	6 ± 1	6 ± 1	0.012
Organized sports, min/week	63± 87	55 ± 82	71 ± 90	0.092
Commuting to and from school, min/week	133 ± 115	143 ± 121	125 ± 109	0.135
Total sedentary activities, min/week	1502 ± 742	1598 ± 772	1414 ± 703	0.020
Total electronic media time, min/week	724 ± 371	644 ± 345	799 ± 379	<0.001

[a] Mean ± SD, [b] Independent samples t-test

Frequency of activities among boys is shown in table 5. The most common activity among boys was spare time weekend exercise that was performed at home (95.6%) while the 10th most frequent activity by boys was spare time drawing at home (55.2%). Weekdays exercise at home and watching television or videos at home were also reported as common activities among boys.

Table 5. The most frequent activities among boys.

	Boys (N=183)
Weekends exercise at home during spare time, n (%)	175 (95.6)
Spare time watching TV or videos at home, n (%)	169 (92.3)
Weekdays exercise at home during spare time, n (%)	167 (91.3)
Spare time unstructured outdoor play, n (%)	159 (86.9)
Spare time unstructured cycling, n (%)	148 (80.9)
Usages of computer or play video games at home during spare time, n (%)	133 (72.7)
Help parents for cleaning, n (%)	120 (65.6)
Spare time unstructured swimming or other water sport, n (%)	118 (64.5)
Spare time unstructured football, n (%)	102 (55.7)
Drawing at home during spare time, n (%)	101 (55.2)

Frequency of activities among girls is shown in table 6. The most common activity among girls was spare time weekend exercise that was performed at home (94.6%) while the 10th most frequent activity by girls was spare time arts and crafts at home (57.5%). Unstructured outdoor play during spare time and watching television or videos at home were also reported as common activities among girls.

Table 6. The most frequent activities among girls.

	Girls (N=167)
Weekends exercise at home during spare time, n (%)	158 (94.6)
Spare time watching TV or videos at home, n (%)	155 (92.8)
Spare time unstructured outdoor play, n (%)	152 (91.0)
Drawing at home during spare time, n (%)	149 (89.2)
Weekdays exercise at home during spare time, n (%)	138 (82.6)
Help parents for cleaning, n (%)	135 (80.8)
Spare time unstructured cycling, n (%)	134 (80.2)
Spare time unstructured skating or figure skating, n (%)	117 (70.1)
Spare time unstructured swimming or other water sport, n (%)	115 (68.9)
Arts and crafts at home during spare time, n (%)	96 (57.5)

5.2. Determinants of physical activity

Analysis was performed by two models i.e. Model 1 and 2, in order to see the difference in the association of determinants with total physical activity in both the models. The variables in both the models were the same as shown in table 1 with the exception of inclusion of electronic media time in model 1 and sedentary activities in model 2.

5.2.1 Model 1

A step wise linear regression analysis (Table 7) revealed that maximal workload per total body lean mass was a highly significant determinant of total physical activity among girls and boys ($\beta = 0.293$, $P < 0.001$). Total body lean mass was also a significant determinant of total physical activity among girls and boys while total body fat percentage, total electronic media time and parents university education had negative association with total physical activity among girls and boys.

Table 7. Determinants of total physical activity (min/week) among girls and boys.

	Beta	P-value [a]
Maximal workload per total body lean mass, W/kg	0.293	<0.001
Total body lean mass, kg	0.228	<0.001
Total body fat percentage, %	-0.256	<0.001
Total electronic media time, min/week	-0.206	<0.001
Parents university education	-0.118	0.014

[a] Stepwise linear regression analysis. Independent variables that are listed in table 1 were entered with the exception of sedentary activities.

We also applied step wise linear regression separately for boys and girls in order to find the differences in determinants of total physical activity in both groups. A step wise linear regression analysis (Table 8) revealed that maximal workload per total body lean mass was a significant determinant of total physical activity among girls ($\beta = 0.321$, $P < 0.001$). Total media electronic time was negatively associated with total physical activity among girls.

Table 8. Determinants of total physical activity (min/week) among girls.

	Beta	P-value [a]
Maximal workload per total body lean mass, W/kg	0.321	<0.001
Total electronic media time, min/week	-0.262	<0.001

[a] Stepwise linear regression analysis. Independent variables that are listed in table 1 were entered with the exception of sedentary activities.

A step wise linear regression analysis (Table 9) revealed that total body lean mass was a highly significant determinant of total physical activity among boys (β = 0.323, P <0.001). Maximal workload per total body lean mass and parents college or other higher vocational degree were also significant determinants of total physical activity among boys while total body fat percentage had negative association with total physical activity.

Table 9. Determinants of total physical activity (min/week) among boys.

	Beta	P-value [a]
Total body lean mass, kg	0.323	<0.001
Maximal workload per total body lean mass, W/kg	0.229	0.001
Parents college or other higher vocational degree	0.160	0.015
Total body fat percentage, %	-0.349	<0.001

[a] Stepwise linear regression analysis. Independent variables that are listed in table 1 were entered with the exception of sedentary activities.

5.2.2 Model 2

A step wise linear regression analysis (Table 10) revealed that maximal workload per total body lean mass was a highly significant determinant of total physical activity among girls and boys (β = 0.282, P <0.001). Total body lean mass and parents college or other higher vocational degree were also significant determinants of total physical activity while total body fat percentage had negative association with total physical activity among girls and boys.

Table 10. Determinants of total physical activity (min/week) among girls and boys.

	Beta	P-value [a]
Maximal workload per total body lean mass, W/kg	0.282	<0.001
Total body lean mass, kg	0.208	<0.001
Parents college or other higher vocational degree	0.126	0.010
Total body fat percentage, %	-0.238	<0.001

[a] Stepwise linear regression analysis. Independent variables that are listed in table 1 were entered with the exception of electronic media time.

We also applied step wise linear regression in Model 2 separately for boys and girls in order to find the differences in determinants of total physical activity in both groups. A step wise linear regression analysis (Table 11) revealed that maximal workload per total body lean mass was a significant determinant of total physical activity, while parent's annual income less than thirty thousand Euros was negatively associated with total physical activity among girls.

Table 11. Determinants of total physical activity (min/week) among girls.

	Beta	P-value [a]
Maximal workload per total body lean mass, W/kg	0.321	<0.001
Parents annual income $\leq$ 30000, Euros	-0.262	0.041

[a] Stepwise linear regression analysis. Independent variables that are listed in table 1 were entered with the exception of electronic media time.

A step wise linear regression analysis (Table 12) revealed that total body lean mass was a highly significant determinant of total physical activity among boys ($\beta = 0.323$, $P < 0.001$). Maximal workload per total body lean mass and parents college or other higher vocational degree were also significant determinants of total physical activity, while total body fat percentage had negative association with boys total physical activity.

Table 12. Determinants of total physical activity (min/week) among boys.

	Beta	P-value [a]
Total body lean mass, kg	0.323	<0.001
Maximal workload per total body lean mass, W/kg	0.229	0.001
Parents college or other higher vocational degree	0.160	0.015
Total body fat percentage, %	-0.349	<0.001

[a] Stepwise linear regression analysis. Independent variables that are listed in table 1 were entered with the exception of electronic media time.

6. DISCUSSION

According to Telama et al. (2005), physical activity performed during school-age has significant impact on physical activity of adults and in broader context the public health of the entire population, as well. Some earlier studies and more specifically the Finnish 2014 Report Card on Physical Activity for Children and Youth also suggested studying the determinants of physical activity at early stage of life (Craggs et al. 2011; Grasten et al. 2014).

Moreover, paucity of literature related to determinants of physical activity especially among children provided the motivation to find the possible determinants in children that can influence the state of health during adolescence and adulthood phase and the association of determinants with total physical activity. The present study showed that there are various determinants that have a relationship to total physical activity in 6-8-years-old school children.

6.1. Main findings

Biological characteristic such as total body fat percentage had a negative association with total physical activity among boys and girls and the results are also in line with earlier study (Ekelund et al. 2006). This study also revealed that total body lean mass was among the strongest physical activity determinants among boys as their physical activity was comparably higher than girls and some earlier studies reported that physical activity increases the body lean mass in children (Regaieg et al., 2013; Lazaar et al., 2007; Schlumpf et al., 2006). Moreover, earlier studies stated that body lean mass is composed of skeletal muscle and larger muscles help to increase the physical activity among children (Farias et al., 2014; Vicente-Rodriguez et al., 2005).

The lack of finding related to the association of total physical activity and sedentary activities confirms that a behavioral aspect does not exert a momentous influence on the total physical activity of 6-8-years school children. Moreover, some earlier studies reported that engagement in the sedentary activities increased with growing age (Sjöström et al., 2006; Muntner et al., 2005; Livingstone et al., 2001). The results of this study didn't show any association of health behavior i.e. snacks and meal intake with total physical activity of children.

This study also illustrated that boys spent more time on electronic media activities than girls and these findings are also in line with the results of earlier studies (Huston et al., 1999; Bianchi & Robinson, 1997). This study demonstrated for the first time that electronic media time had negative association with total physical activity among 6-8-years-old boys and girls and the findings are not in line with earlier study that reported the positive association of electronic media time and physical activity among children (Strasburger et al. 2012).

Boys' engagement in physical activity behaviors was apparently higher as compared to girls while engagement in sedentary behaviors was comparatively higher among girls than boys and these results are also in line with results that have been found in some previous studies in children (Colley et al., 2011; Verloigne et al., 2008; Ness et al., 2007). Boy's higher physical activity can be most likely due to positive association of parent's college or other high vocational degree with total physical activity. Moreover, there was a significant difference in parent's high income level among boys as compared to girls and these findings are also in line with earlier studies (Lehto et al., 2009; Gordon-Larsen et al., 2004).According to results, boys spent more time in structured and unstructured physical activity which is also another reason of boy's higher physical activity than girls.

High scores in fitness tests were observed among boys and according to earlier study it indicates the beneficial effects of physical activity on growth and development of boys than girls who reported lower physical activity (Trudeau & Shephard, 2008). This study demonstrated that cardiorespiratory fitness i.e. maximum workload, and body lean mass were the most significant determinants of physical activity among boys and girls and these findings are also in line with previous studies (Aires et al., 2011; Ness et al., 2007; Nemet et al., 2005; Ara et al., 2006; Brage et al., 2004). The positive association of cardiorespiratory fitness with total physical activity of children and adolescents indicates the capability to perform prolonged exercise and children's physical activity also varies according to the type of exercise (Strong et al., 2005; Gutinet al., 2005; Andersen et al., 2006).

The negative association of parents' university education and total physical activity among children can be due to the priority of parents for academic research work or busy professional life with more responsibilities at workplace. Parental education i.e. college or other high vocational degree had a positive association with total physical activity of boys

and girls and these findings are also in line with recent two studies conducted on children in Germany (Erkelenz et al., 2014; Finger et al., 2014). It can be assumed after the aforementioned findings that educated parents will comparatively provide better support and encouragement for physical activity to their children than uneducated parents. This study found negative association between low household income and total physical activity among girls and these findings are not in line with some earlier studies which stated that income does not influence the physical activity levels of young age school children (Ferreira et al., 2007; Ball et al., 2009).

The negative association of total body fat percentage, low household income and electronic media time, and positive association of cardiorespiratory fitness, total body lean mass and parent's education with children's physical activity also provide evidence in the differences of determinants among children, adolescents and adults. SES, socio-cultural and sedentary behavior are usually the most common determinants of physical activity during later stages of life due to engagement in employment, parent's economic conditions and decline of physical activity by following unhealthy lifestyle.

6.2. Strengths and limitations

The strength of this study include large sample size of healthy boys and girls and broad assessment of physical activity and sedentary behaviors by PANIC Physical Activity Questionnaire which was useful to find the potential determinants of physical activity among children. Strength of this study was also related to the questions that were asked both in duration and frequency of activities that were performed during school and spare time which provide the entire depiction for finding the association of determinants and total physical activity. Moreover, physical activity is a multi-dimensional behavior and vital strength of this study was to compare the multiple independent variables with total physical activity. Physical Activity Questionnaire was validated by Actiheart monitor on a subsample of children and the results suggested positive correlation between questionnaire and Actiheart monitor results for total physical activity among children (Väistö et al. 2014).

We analyzed the data by linear regression analysis which gives the cross-sectional relationship of physical activity behavior with total physical activity. Therefore, cross-sectional study design did not allow us to infer the possible causal relationship between the determinants total physical activity among children. The data collection was done by the

PANIC Physical Activity Questionnaire and we relied mostly on parent's statement as children's capability to answer questions has always been challenging because they cannot recall and report everything about their physical activity due to weak cognitive process at this premature age. The children's reliability can only be raised by pre-contrived sports competitions and exercise activities and by providing motivation in terms of grades for participation in physical education by school teachers.

6.3. Future recommendations

It is suggested to conduct longitudinal study that will provide a snapshot over an extended period of time and determine the path of causation. Most of the children in this study were financially stable as their parent's income level was mainly average to higher and hence it is pertinent to conduct this study on those children who belong to poor families in order to compare the differences in determinants in both poor and rich families.

Moreover, this study was conducted in Finland and Finnish society is well known for its high literacy and zero crime rate, therefore it is suggested to conduct this study in a country with low literacy and high crime rates because these factors exerts a significant impact on children's physical activity levels. The role and impact of different biomarkers on children's physical activity can also be studied because the literature on this particular subject with reference to children has not been studied comprehensively in earlier studies.

7. CONCLUSION

This study demonstrated that cardiorespiratory fitness, total body lean mass, total body fat percentage, electronic media time, low household income and parent's education were the key determinants which had a significant association with total physical activity of 6-8-years-school children. The causality of all these key determinants can only be determined by conducting further studies. Moreover, primary school boys of Kuopio reported higher physical activity than girls while girl's participation in sedentary activities was comparatively higher than boys.

Health behavior i.e. meals and snack intake, and sedentary activities didn't exert any significant impact on total physical activity of 6-8-years-school children. Therefore, it is recommended to target effective interventions for aforementioned momentous determinants in order to improve the levels of physical activity among children in future.

8. REFERENCES

Aires, L., Pratt, M., Lobelo, F., Santos, RM., Santos, MP., Mota, J. (2011). Associations of cardiorespiratory fitness in children and adolescents with physical activity, active commuting to school, and screen time. Journal of Physical Actviity and health, 2, 198-205.

Andersen, LB., Harro, M., Sardinha, LB., Froberg, K., Ekelund, U., Brage, S., Anderssen, SA. (2006). Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). Lancet, 368, 299-304.

Anderssen, N., & Wold, B. (1992). Parental and peer influences on leisure-time physical activity in young adolescents. Research Quarterly for Exercise and Sport, 63, 341-348.

Ara, I., Vicente-Rodriguez, G., Perez-Gomez, J., Jimenez-Ramirez, J., Serrano-Sanchez, JA., Dorado, C., Calbet, JA. (2006). Influence of extracurricular sport activities on body composition and physical fitness in boys: a 3-year longitudinal study. International Journal of Obesity, 30, 1062-71.

Ar-Yuwat, S., Clark, MJ., Hunter, A., James, KS. (2013). Determinants of physical activity in primary school students using the health belief model. Journal of Multidisciplinary Healthcare, 6, 119-126.

Ball, K., Cleland, VJ., Timperio, AF., Salmon, J., Crawford, DA. (2009). Socioeconomic position and children's physical activity and sedentary behaviors: longitudinal findings from the CLAN study. Journal of Physical Activity and Health, 6, 289-298.

Becker, M. H. (Ed.). (1974). Health belief model and personal health behavior. Health Education Monographs, 2, entire issue.

Bianchi, S. M., Robinson, J. (1997). What did you do today? Children's use of time, family composition, and acquisition of social capital. Journal of Marriage and the Family, 59, 332-344.

Blair, SN. (2009). Physical inactivity: the biggest public health problem of the 21st century. British Journal of Sports Medicine, 43, 1–2

Brage S, Wedderkopp N, Ekelund U, Franks PW, Wareham NJ, Andersen LB, Froberg K. (2004). Features of the metabolic syndrome are associated with objectively measured

physical activity and fitness in Danish children: the European Youth Heart Study (EYHS). Diabetes Care, 27, 2141–8.

Belanger, M., Gray-Donald, K., O'Loughlin, J., Paradis, G., Hanley, J. (2009). Influence of weather conditions and season on physical activity in adolescents. Annals of Epidemiology, 19, 180–86.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. Psychological Review, 84, 191-215.

Ball, K., Cleland, VJ., Timperio, AF., Salmon, J., Crawford, DA. (2009). Socioeconomic position and children's physical activity and sedentary behaviors: longitudinal findings from the CLAN study. Journal of Physical Activity and Health, 6, 289-98.

Carpenter, CJ. (2010). A meta-analysis of the effectiveness of health belief model variables in predicting behavior. Health Communication, 25, 661–669.

Cairney, J., Veldhuizen, S., Kwan, M., Hay, J., Faught, BE. (2014). Biological age and sex-related declines in physical activity during adolescence. Medicine and Science in Sports and Exercise, 46, 730-5.

Colley, RC., Garriguet, D., Janssen, I., Craig, C., Clarke, J., Tremblay, MS. (2011). Physical activity of Canadian children and youth: Accelerometer results from the 2007-2009 Canadian Health Measures Survey. Health Reports, 22, 15-23.

Colley, RC., Garriguet, D., Adamo, KB., Carson, V., Janssen, I., Timmons, BW., Tremblay, MS. (2013). Physical activity and sedentary behavior during the early years in Canada: a cross-sectional study. International Journal of Behavioral Nutrition and Physical Activity, 10, 54.

Corder K, Ogilvie D, van Sluijis EM. (2009). Physical activity over the life course: Whose behavior changes, when and why? American Journal of Epidemiology, 170, 1078-1083.

Craggs, C., Corder, K., van Sluijs, EM., Griffin, SJ. (2011). Determinants of change in physical activity in children and adolescents: a systematic review. American Journal of Preventive Medicine, 40, 645-58.

Dumith, SC., Gigante, DP., Domingues, MR., Kohl, HW 3rd. (2011). Physical activity change during adolescence: a systemic review and a pooled analysis. International Journal of Epidemiology, 40, 685-98.

Davison, K., Cutting, T., & Birch, L. (2003). Parents' activity-related parenting practices predict girls' physical activity. Medicine and Science in Sports and Exercise, 35, 1589-1595.

Davison, K. (2004). Activity-related support from parents, peers, and siblings and adolescents' physical activity: Are there gender differences? Journal of Physical Activity and Health, 1, 363-376.

Davison, K., & Schmalz, D. (2006). Youth at risk of physical inactivity may benefit more from activity-related support than youth not at risk. International Journal of Behavioral Nutrition and Physical Activity, 3, 5-12.

D'Elio, MA., Mundt, DJ., Bush, PJ., Iannotti, RJ. (1993). Healthful behaviors: do they protect African-American, urban preadolescents from abusable substance use? American Journal of Health Promotion, 7, 354-63.

Dishman, R., Motl, R., Saunders, R., Felton, G., Ward, D., Dowda, M. et al. (2005). Enjoyment mediates effects of school-based physical activity intervention. Medicine and Science in Sports and Exercise, 37, 478-487.

Dishman, R., Saunders, R., Felton, G., Ward, D., Dowda, M., & Pate, R. (2006). Goals and intentions mediate efficacy beliefs and declining physical activity in high school girls. American Journal of Preventive Medicine, 6, 475-483.

Deforche, B., De Bourdeaudhuij, I., Tanghe, A., Hills, AP., De Bode, P. (2004). Changes in physical activity and psychosocial determinants of physical activity in children and adolescents treated for obesity. Patient Education and Counseling, 55, 407-15.

Ekelund, U., Brage, S., Froberg, K., Harro, M., Anderssen, SA., Sardinha, LB., Riddoch, C., Andersen, LB. (2006). TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. PLoS medicine, 3, 12, e488.

Erkelenz, N., Schreiber, AC., Kobel, S., Kettner, S., Drenowatz, C., Steinacker, JM. (2014). Relationship of parental health-related behaviours and physical fitness in girls and boys. Zeitschrift fur Gesundheitswissenschaften, 22, 407-414.

Epstein, LH., Paluch, RA., Gordy, CC., Dorn, J. (2000). Decreasing sedentary behaviors in treating pediatric obesity. Archives of Pediatrics and Adolescent Medicine, 154, 220-6.

Farias, ED., Gonçalves, EM., Morcillo, AM., Guerra-Júnior, G., Amancio, OM. (2014). Effects of Programmed Physical Activity on Body Composition in Post-Pubertal Schoolchildren. Jornal de pediatria, pii: S0021-7557, 00141-7

Felton, G., Dowda, M., Ward, D., Dishman, R., Trost, S., Saunders, R. et al. (2002). Differences in physical activity between Black and White girls living in rural and urban areas. Journal of School Health, 72, 250-255.

Ferreira, I., Van Der Horst, K., Wendel-Vos, W., Kremers, S., Van Lenthe, FJ., Brug, J. (2007). Environmental correlates of physical activity in youth – a review and update. Obesity Reviews, 8, 289-298.

Finger, JD., Mensink, GB., Banzer, W., Lampert, T., Tylleskär, T. (2014). Physical activity, aerobic fitness and parental socio-economic position among adolescents: the German Health Interview and Examination Survey for Children and Adolescents 2003-2006 (KiGGS). International Journal of Behavioral Nutrition and Physical Activity, 11, 43.

Garcia, A., Pender, N., Antonakos, C., & Ronis, D. (1998). Changes in physical activity beliefs and behaviors of boys and girls across the transition to junior high school. Journal of Adolescent Health, 22, 394-402.

Glanz, K., Rimer, B. K., & Viswanath, K. (2008). Health behavior and health education: theory, research, and practice. San Francisco, CA, Jossey-Bass.

Gordon-Larsen, P., McMurray, R., & Popkin, B. (2000). Determinants of adolescent physical activity and inactivity patterns. Pediatrics, 105, 83-90.

Gordon-Larsen, P., McMurray, R., Popkin, B. (2004). Determinants of adolescent physical activity and inactivity patterns. Pediatrics, 105, 83-90

Gordon-Larsen, P., Nelson, MC., Popkin, BM. (2004). Longitudinal physical activity and sedentary behaviortrends: Adolescence to adulthood. American Journal of Preventive Medicine, 27, 277-283.

Grasten, A., Liukkonen, J., Jaakkola, T., Tammelin, T. (2014). The Finnish 2014 Report Card on Physical Activity for Children and Youth. Available from: https://www.

jyu.fi/sport/ReportCard/.

Gustafson, S., & Rhodes, R. (2006). Parental correlates of physical activity in children and early adolescents. Sports Medicine, 36, 79-97.

Gutin, B., Yin, Z., Humphries, MC., Barbeau, P. (2005). Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. American Journal of Clinical Nutrition, 81, 746-750.

Hallal PC, Wells JC, Reichert FF, Anselmi L, Victora CG. (2006). Early determinants of physical activity in adolescence: prospective birth cohort study. BMJ, 332, 1002-7.

Health topics: Physical Activity. World Health Organization 2014. (Accessed 03.06.2014). http://www.who.int/topics/physical_activity/en/

Heitzler, C., Martin, S., Duke, J., & Huhman, M. (2006). Correlates of physical activity in a national sample of children aged 9-13 years. Preventive Medicine, 42, 254-260.

Higgins, JW., Gaul, C., Gibbons, S., Van Gyn, G. (2003). Factors influencing physical activity levels among Canadian youth. Canadian Journal of Public Health, 94(1), 45-51.

Hochbaum, G. M. (1958). Public participation in medical screening programs: A sociopsychological study (PHS publication no. 572). Washington, DC: U.S. Government Printing Office.

Huston, AC., Wright, JC., Marquis, J., Green, SB. (1999). How young children spend their time: television and other activities. Developmental Psychology, 35, 912-25.

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. Health Education Quarterly, 11, 1-47.

Janz, N. K., Champion, V. L., & Strecher, V. J. (2002). The health belief model. In K. Glanz, B. K. Rimer, & F. M. Lewis (Eds.), Health behavior and health education: Theory, research, and practice (3rd ed., pp. 45-66). San Francisco, CA: John Wiley & Sons, Inc.

Kirscht, J. P. (1974). The health belief model and illness behavior. Health Education Monographs, 2, 2387-2408.

Kohl, HW 3rd., Hobbs, KE. (1998). Development of physical activity behaviors among children and adolescents. Pediatrics, 101(3 Pt 2), 549-54.

Lazaar, N., Aucouturier, J., Ratel, S., Rance, M., Meyer, M., Duché, P. (2007). Effect of physical activity intervention on body composition in young children: influence of body mass index status and gender. Acta paediatrica, 96, 1315-20

Lehto, R., Corander, C., Ray, C., Roos, E. (2009). Perheen sosioekonomisen aseman ja perherakenteen yhteydetalakouluikäisten lasten terveellisiin elintapoihin. Sosiaalilääketieteellinen aikakauslehti, 46, 258–271.

Lindquist, C., Reynolds, K., & Goran, M. (1999). Socio-cultural determinants of physical activity among children. Preventive Medicine, 29, 305-312.

Livingstone, MB., Robson PJ, McCarthy S, Kiely M, Harrington K, Browne P, Galvin, M., Wareham, NJ., Rennie, KL. (2001). Physical activity patterns in a nationally representative sample of adults in Ireland. Public Health Nutrition, 4, 1107-16.

Lemmon, C., Ludwig, D., Howe, C., Ferguson-Smith, A., & Barbeau, P. (2007). Correlates of adherence to a physical activity program in young African- American girls. Obesity, 15, 695-703.

Matthews, CE., Chen, KY., Freedson, PS., Buchowski, MS., Beech, BM., Pate, RR., Troiano, R. (2008). Amount of time spent engaging in sedentary behaviours in the United States 2003-2004. American Journal of Epidemiology, 167, 875-81.

McKenzie, TL., Sallis, JF., Nader, PR., Broyles, SL., Nelson, JA. (1992). Anglo- and Mexican-American preschoolers at home and at recess: activity patterns and environmental influences. Journal of Developmental & Behavioral Pediatrics, 13, 173–180.

Ministry of Social Affairs and Health. (2005). Recommendations for physical activity in early childhood education. Handbook of the Ministry of Social Affairs and Health 2005:17. Helsinki.

Molnar, B., Gortmaker, S., Bull, F., & Buka, S. (2004). Unsafe to play? Neighborhood disorder and lack of safety predict reduced physical activity among urban children and adolescents. American Journal of Health Promotion, 18, 378-386.

Moore, LL., Gao, D., Bradlee, ML., Cupples, LA., Sundarajan-Ramamurti, A., Proctor, MH., Hood, MY., Singer, MR., Ellison, RC. (2003). Does early physical activity predict body fat change throughout childhood? Preventive Medicine, 10, 10-17.

Moore, L., Lombardi, D., White, M., Campbell, J., Oliveria, S., & Ellison, R. (1991). Influence of parents' physical activity levels on activity levels of young children. Journal of Pediatrics, 118, 215-219.

Motl, R., Dishman, R., Saunders, R., Dowda, M., Felton, G., Ward, D. et al. (2002). Examining socio-cognitive determinants of intention and physical activity among Black and White adolescent girls using structural equation modeling. Health Psychology, 21, 459-467.

Muntner, P., Gu, D., Wildman, RP., Chen, J., Qan, W., Whelton, PK., He, J. (2005). Prevalence of physical activity among Chinese adults: results from the International Collaborative Study of Cardiovascular Disease in Asia. American Journal of Public Health, 95, 1631-6.

Nader, PR., Bradley, RH., Houts, RM., McRitchie, SL., O'Brien, M. (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. Journal of American Medical Association, 300, 295–305.

Nahas, M. V., Goldfine, B., & Collins, M. A. (2003). Determinants of physical activity in adolescents and young adults: The basis for high school and college physical education to promote active lifestyles. Physical Educator, 60, 42-56.

Nelson, M., Gordon-Larsen, P., Song, Y., & Popkin, B. (2006). Built and social environments: Associations with adolescent overweight and activity. American Journal of Preventive Medicine, 31, 109-117.

Nemet, D., Barkan, S., Epstein, Y., Friedland, O., Kowen, G., Eliakim, A. (2005). Short- and long-term beneficial effects of a combined dietary-behavioral-physical activity intervention for the treatment of childhood obesity. Pediatrics, 115, 443-9.

Ness, AR., Leary, SD., Mattocks, C., Blair, SN., Reilly, JJ., Wells, J., Ingle, S., Tilling, K., Smith, GD., Riddoch, C. (2007). Objectively measured physical activity and fat mass in a large cohort of children, PloS Medicine, 4, e97.

O'Loughlin, J., Paradis, G., Kishchuk, N., Barnett, T., Renaud, L.Prevalence. (1999). Prevalence and correlates of physical activity behaviors among elementary schoolchildren in multiethnic, low income, inner-city neighborhoods in Montreal, Canada. Annals of Epidemiology, 9, 397–407.

Ornelas, I., Perreira, K., & Ayala, G. (2007). Parental influences on adolescent physical activity: A longitudinal study. International Journal of Behavioral Nutrition and Physical Activity, 4, 3-13.

Pate, R., Heath, G., Dowda, M., & Trost, S. (1996). Associations between physical activity and other health behaviors in a representative sample of U.S. adolescents. American Journal of Public Health, 86, 1577-1581.

Pate, RR., Trost, SG., Felton, GM., Ward, DS., Dowda, M., Saunders, R. (1997). Correlates of physical activity behavior in rural youth. Research Quarterly for Exercise and Sport, 68, 241-8.

Pate, RR., O'Neill, JR., Lobelo, F. (2008). The evolving definition of "sedentary". Exercise and Sport Sciences Reviews, 36, 173-8.

Prochaska, J., Rodgers, M., & Sallis, J. (2002). Association of parent and peer support with adolescent physical activity. Research Quarterly for Exercise and Sport, 73, 206-210.

Regaieg, S., Charfi, N., Kamoun, M., Ghroubi, S., Rebai, H., Elleuch, H., Feki, MM., Abid, M. (2013). The effects of an exercise training program on body composition and aerobic capacity parameters in Tunisian obese children. Indian Journal of Endocrinology and Metabolism, 17, 1040-5.

Reynolds, KD., Killen, JD., Bryson, SW., Maron, DJ., Taylor, CB., Maccoby, N., Farquhar, JW. (1990). Psychosocial predictors of physical activity in adolescents. Preventive Medicine, 19, 541-51.

Rosenstock, I. M. (1974). Historical origins of the health belief model. Health Education Monographs, 2, 328-335.

Sallis, JF., Alcaraz, JE., McKenzie, TL., Hovell, MF., Kolody, B., Nader, PR. (1992). Parental behavior in relation to physical activity and fitness in 9-year old children. American Journal of Diseases of Children, 146, 1383-8.

Sallis, J.F., & Owen, N. (1999). Physical activity and behavioral medicine. Thousand Oaks, CA: SAGE Publications.

Sallis, JF., Alcaraz, JE., McKenzie, TL., Hovell, MF. (1999a). Predictors of change in children's physical activity over 20 months. Variations by gender and level of adiposity. American Journal of Preventive Medicine, 16, 222-9.

Sallis, J., Prochaska, J., Taylor, W., Hill, J., & Geraci, J. (1999b). Correlates of physical activity in a national sample of girls and boys in grades 4 through 12. Health Psychology, 18, 410-415.

Sallis, J., Prochaska, J., & Taylor, W. (2000). A review of correlates of physical activity of children and adolescents. Medicine and Science in Sports and Exercise, 32, 963-975.

Schlumpf, M., Eiholzer, U., Gygax, M., Schmid, S., van der Sluis, I., l'Allemand, D. (2006). A daily comprehensive muscle training programme increases lean mass and spontaneous activity in children with Prader-Willi syndrome after 6 months. Journal of Pediatric Endocrinology and Metabolism, 19, 65-74.

Schmitz, K., Lytle, L., Phillips, G., Murray, D., Birnbaum, A., & Kubik, M. (2002). Psychosocial correlates of physical activity and sedentary leisure habits in young adolescents: The teens eating for energy and nutrition at school study. Preventive Medicine, 34, 266-278.

Sigmund, E., De Ste Croix, M., Miklankova, L., Fromel, K. (2007). Physical activity patterns of kindergarten children in comparison to teenagers and young adults. European Journal of Public Health, 17, 646-51.

Sjöström, M., Oja, P., Hagströmer, M., Smith, B. J., Bauman, A. (2006). Health-enhancing physical activity across European Union countries: The Eurobarometer study. Journal of Public Health, 14, 291-300.

Saari, A., Sankilampi, U., Hannila, ML., Kiviniemi, V., Kesseli, K,, Dunkel, L. (2011). New Finnish growth references for children and adolescents aged 0 to 20 years: length/height-for-age, weight-for-length/height, and body mass index-for-age. Annals of Medicine, 43, 235-248.

Strasburger, VC., Jordan, AB., Donnerstein, E. (2012). Children, adolescents, and the media: health effects. Pediatric Clinics of North America, 59, 533-87.

Strauss, R., Rodzilsky, D., Burack, G., & Colin, M. (2001). Psychosocial correlates of physical activity in healthy children. Archives of Pediatrics and Adolescent Medicine, 155, 897-902.

Strong, WB., Malina, RM., Blimkie, CJ., Daniels, SR., Dishman, RK., Gutin, B., Hergenroeder, AC., Must, A., Nixon, PA., Pivarnik, JM., Rowland, T., Trost, S., Trudeau, F. (2005). Evidence based physical activity for school-age youth. The Journal of Pediatrics, 146, 732-7.

Stucky-Ropp, RC., DiLorenzo, TM. (1993). Determinants of exercise in children. Preventive Medicine, 22, 880–889.

Taylor, WC., Baranowski, T., Sallis, JF. (1994). Family determinants of childhood physical activity: a social-cognitive model. In: Dishman RK, ed. Advances in Exercise Adherence. Champaign, III: Human Kinetics, 319-342.

Taylor, WC., Baranowski, T., Young, DR. (1998). Physical activity interventions in low-income, ethnic minority, and populations with disability. American Journal of Preventive Medicine, 15, 334–343.

Terre, L., Drabman, RS., Meydrech, EF. (1990). Relationships among children's health-related behaviors: a multivariate, developmental perspective. Preventive Medicine, 19, 134–46.

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., Raitakari, O. (2005). Physical activity from childhood to adulthood: a 21-year tracking study. American Journal of Preventive Medicine, 28, 267-73.

Thomas, JR., Thomas, KT. (1988). Development of gender differences in physical activity. Quest, 40, 219–229.

Tinsley, BJ., Holtgrave, DR., Reise, SP., Erdley, C., Cupp, RG. (1995). Developmental status, gender, age, and self-reported decision-making influences on students' risky and preventive health behaviors. Health Education Quarterly, 22, 3244–259.

Tremblay, MS., LeBlanc, AG., Kho, ME., Saunders, TJ., Larouche, R., Colley, RC., Goldfield, G., Connor Gorber, S. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. International Journal of Behavioral Nutrition and Physical Activity, 8, 98.

Trost, S., Sallis, J., Pate, R., Freedson, P., Taylor, W., & Dowda, M. (2003). Evaluating a model of parental influence on youth physical activity. American Journal of Preventive Medicine, 25, 277-282.

Trost, S., Pate, R., Ward, D., Saunders, R., & Riner, W. (1999a). Correlates of objectively measured physical activity in preadolescent youth. American Journal of Preventive Medicine, 17, 120-126.

Trost, S., Pate, R., Dowda, M., Ward, D., Felton, G., & Saunders, R. (2002a). Psychosocial correlates of physical activity in White and African-American girls. Journal of Adolescent Health, 31, 226-233.

Trost, SG., Pate, RR., Saunders, R., Ward, DS., Dowda, M., Felton G. (1997). A prospective study of the determinants of physical activity in rural fifth-grade children. Preventive Medicine, 26, 257-63.

Trost, SG., Pate, RR., Ward, DS., Saunders, R., Riner, W. (1999b). Determinants of physical activity in active and low active, sixth grade African-American youth. Journal of School Health, 69, 29-34.

Trost, SG., Kerr, LM., Ward, DS., Pate, RR. (2001). Physical activity and determinants of physical activity in obese and non-obese children. International Journal of Obesity and Related Metabolic Disorders, 25, 822-9.

Trost, SG., Pate, RR., Dowda, M., Saunders, R., Ward, DS., Felton, G. (1996). Gender differences in physical activity and determinants of physical activity in rural fifth grade children. Journal of School Health, 66, 145-50.

Trudeau, F., Shephard, RJ. (2008). Physical education, school physical activity, school sports and academic performance. International Journal of Behavioral Nutrition and Physical Activity, 5, 10.

U.S. Department of Health and Human Services. Physical Activity and Health: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.

Väistö, J., Eloranta, AM., Viitasalo, A., Tompuri, T., Lintu, N., Karjalainen, P., Lampinen, EK., Ågren, J., Laaksonen, DE., Lakka, HM., Lindi, V., Lakka, TA. (2014). Physical activity and sedentary behaviour in relation to cardiometabolic risk in children: cross-sectional findings from the Physical Activity and Nutrition in Children (PANIC) Study. International Journal of Behavioral Nutrition and Physical Activity, 11, 55.

Van Sluijs EM, McMinn AM, Griffin SJ. (2007). Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. British Medical Journal, 335, 703.

Van Der Horst, K., Paw, MJ, Twisk, JW., Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. Medicine and Science in Sports and Exercise, 39, 1241–1250.

Verloigne, M., Van Lippevelde, W., Maes, L., Yıldırım, M., Chinapaw, M., Manios, Y., Androutsos, O., Kovács, E., Bringolf-Isler, B., Brug, J., De Bourdeaudhuij, I. (2012). Levels of physical activity and sedentary time among 10- to 12-year-old boys and girls across 5 European countries using accelerometers: An observational study within the ENERGY-project. International Journal of Behavioral Nutrition and Physical Activity, 9, 34.

Vicente-Rodriguez, G., Ara, I., Perez-Gomez J., Dorado, C., Calbet, J. (2005). Muscular development and physical activity as major determinants of femoral bone mass acquisition during growth. British Journal of Sports Medicine, 39,611–6.

Viitasalo, A., Laaksonen, DE., Lindi, V., Eloranta, AM., Jääskeläinen, J., Tompuri, T., Väisänen, S., Lakka, HM., Lakka, TA. (2012). Clustering of metabolic risk factors is

associated with high-normal levels of liver enzymes among 6- to 8-year-old children: the PANIC study. Metabolic Syndrome and Related Disorders, 10, 337-43.

Ward, D., Dowda, M., Trost, S., Felton, G., Disman, R., & Pate, R. (2006). Physical activity correlates in adolescent girls who differ by weight status. Obesity, 14, 97-105.

Whitt-Glover, MC., Taylor, WC., Floyd, MF., Yore, MM., Yancey, AK., Matthews, CE. (2009). Disparities in physical activity and sedentary behaviors among US children and adolescents: prevalence, correlates, and intervention implications. Journal of Public Health Policy, 30, 309-34.

Whitlock, EP., O'Connor, EA., Williams, SB., Beil, TL., Lutz, KW. (2010). Effectiveness of weight management interventions in children: A targeted systematic review for the USPSTF. Pediatrics, 125, 396-418.

World Health Organization Technical Report Series. Diet, nutrition and the prevention of chronic diseases; 2003 [Geneva]

[http://www.who.int/dietphysicalactivity/publications/trs916/download/en/index.html].

World Health Assembly 57.17. Global Strategy on Diet and Physical Activity. Geneva: WHO, 2004.

WHO. The World Health Report 2002: Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization, 2002.

WHO. (2014). Physical activity (factsheet). Retrieved from: http://www.who.int/mediacentre/factsheets/fs385/en/.

Zakarian, JM., Hovell, MF., Hofstetter, CR., Sallis, JF., Keating, KJ. (1994). Correlates of vigorous exercise in a predominantly low SES and minority high school population. Preventive Medicine, 23, 314-21.

Zimmermann-Sloutskis, D., Wanner, M., Zimmermann, E., Martin, BW. (2010). Physical activity levels and determinants of change in young adults: a longitudinal panel study. International Journal of Behavioral Nutrition and Physical Activity, 7, 2.